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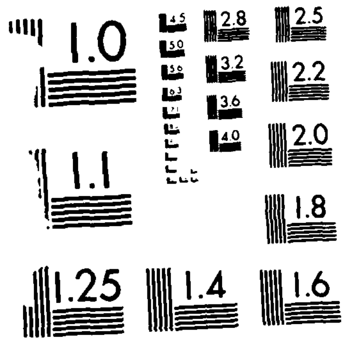

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US Army Corps
of Engineers
Norfolk District

AD-A165 252

Analysis of a Dredged Material Disposal Operation

Dam Neck Ocean Disposal Site, Virginia

US Army Corps
Of Engineers
Norfolk District

March 1985

Report B- 47

ANALYSIS OF A DREDGED MATERIAL DISPOSAL OPERATION

DAM NECK OCEAN DISPOSAL SITE VIRGINIA

MARCH 1985

STEPHEN R. DELOACH

**US ARMY CORPS OF ENGINEERS
NORFOLK DISTRICT**

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Purpose of this study was to: (a) determine the Corps ability to construct an underwater feature utilizing predominately fine grained maintenance dredging material, and (b) enhance the Corps ability to monitor and predict the stability of the feature and its effects on surrounding topography. Conclusion arrived at was that the only loss of dredged material from the site was the direct result of settlement of scour along the crest due to various storms which passed through the area. The computed volume change was not within the error limits of state-of-the-art bathymetric survey methods.

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I. PURPOSE OF STUDY

The Norfolk District, Corps of Engineers, is presently performing engineering studies for the proposed deepening of the port of Hampton Roads. This project will require the removal of tens of millions of cubic yards of material from the various channels. Subsequently, many of the studies are to determine the best disposal alternatives for this material.

It is necessary for a large part of this material to be placed in offshore, open ocean, disposal areas. Because of travel time between dredging area and disposal site, this type of operation can become extremely expensive. The disposal area should be as close to the dredging area as possible. The constraints on this distance are both environmental and physical. Based on various criteria, the Norfolk District proposed to continue using the existing Dam Neck Disposal Site for the deepening projects.

Technological advances in dredging capabilities, vessel positioning, and hydrographic surveying have increased the engineer's capability to initiate innovative disposal alternatives. One of these is the precise placement of the material to minimize adverse physical and environmental impacts, or to even create possible benefits.

As a result, the first step of this study was to dispose in a "test area" to: (a) determine the Corps' ability to construct an underwater feature utilizing predominantly fine grained maintenance dredging material (worst case); and (b) to enhance the Corps' ability to monitor and predict the stability of the feature and its effects on surrounding topography.

II. SCOPE OF WORK

In the Summer of 1982, the plans and specifications were being prepared to perform maintenance dredging in Thimble Shoal and Cape Henry channels. Generally, the materials from these projects were in the past disposed of in the Dam Neck Disposal Area with a minimum of control over the specific point of release. At this same time, the idea of a controlled disposal was introduced.

The key element of this study was precise control over the exact position of release. Usually ocean disposal areas are several miles in extent, and no special effort is made to release the material in any particular place within the overall designated areas. For the dredging planned in the fall of 1982 the Corps attempted to closely control the dumping location without complicating the operation or significantly adding to the cost of the project. Two positioning methods were specified in the dredging contract: (1) the dredge was to utilize a precise navigation system at the disposal site and (2) three navigation buoys were placed at the site.

The modern hopper dredge industry routinely uses precise electronic navigation systems to position its equipment while dredging. Therefore, it was very little additional burden to also require electronic positioning at the disposal site. The navigation buoys were used to mark the dump site as a backup to the navigation system should the electronic equipment fail. These buoys were placed in a straight line about 200 feet off the proposed dumping centerline and 1000 feet apart with the center buoy being on the midpoint of the proposed dump area.

The dredges were allowed to dump while underway which is normal hopper dredge procedure. However, they were required to slow from about 10 knots to 2-3 knots before opening the hopper. The dredging and disposal were accomplished by the Sugar Island and the Manhatten Island, two self-propelled, split hull hopper dredges. About 854,000 cubic yards of silt and very fine sand were dredged and dumped between August and November 1982. A grain size analysis of the material yielded an average size less than 0.2 mm.

III. SURVEYS

To monitor the disposal and subsequent stability of the material, a survey area was set up centered around the dump point. This area was 4000 feet wide and 7000 feet long. Survey cross-sections were run across the width of the area on 200-foot stations. A total of six surveys were completed over the area: one before disposal began; one after approximately 1/3 of the material had been placed and four after completion of the project. The dates of these surveys are: June 1982, September 1982, February 1983, June 1983, November 1983 and February 1985.

The surveys were run on the 42-foot survey vessel LYNNHAVEN. She is an all aluminum boat, with twin screws and a 25 kw generator for the survey electronics. She was designed specifically for hydrographic surveying and is capable in the open ocean environment.

A Digital Equipment Corporation PDP-8E is the heart of the survey system. The software was specially developed by hydrographic surveyors and engineers over many years to optimize the accuracy and efficiency of data collection, while maintaining a systemized format for further computerized mathematical modeling and engineering applications.

Precise navigation is obtained from either of two systems; a Raydist range-range non-line-of-sight system, or a Tellurometer 3 range, line-of-sight system. Spar buoys, positioned from shore are used to calibrate and verify positions when using the Raydist. When using the redundant ranging Tellurometer, a least squares fit of the ranges is used to minimize the residuals of the error ellipse. Should these become too large, the surveyor must take further action to verify his position, or reject the work. Each system requires the installation of shore stations on known points. These points are either National Geodetic Survey or Corps of Engineers monuments established following Third Order or better procedures as specified by the Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys, as established by the Federal Geodetic Control Committee.

Depths are measured with a Ross Fineline Depth Recorder. The bar check method is used to correct for variations of speed of sound in water. These checks are performed before and after a days work to verify that no drifts in the sound velocity have occurred during the day. The vertical datum used is National Ocean Service (NOS) Mean Low Water (MLW).

This datum was established through a cooperative agreement between the National Ocean Service and the Corps of Engineers. The tide station was on the Virginia Beach Fishing Pier which is almost due west of the disposal area. This station is a secondary tidal station named Virginia Beach, Atlantic Ocean. The tidal datum is based on the following:

Length of Series	= 6 years
Time Period	= 1964, 1966 - 1970
Tidal Epoch	= 1960 - 1978
Control Tide Station	= Hampton Roads

Because the Dam Neck Site is about 4 miles offshore, an error in the datum occurs because of the progression of the tidal wave as it moves onshore. This lag in time and height of the wave is corrected by a tidal zoning of the area which was also prepared by NOS.

All of the equipment and procedures used to complete a survey exceed the Accuracy Standards recommended for Hydrographic Surveys as stated by the International Hydrographic Bureau (1968) Special Publication 44.

Processing of the data (editing, plotting and computations) was performed on an interactive system comprised of a WANG 2200 MVP, Tektronix 4054 and Calcomp 965.

The analysis of the six surveys involved making comparisons of cross-sections, volumes and contours. With the aid of the in-house computer system, it was possible to mathematically model the topography of the disposal area. Overlays were created comparing one survey to the next as well as a time progression showing all the surveys.

IV. DATA ANALYSIS

The cross-sections were processed through the Tektronix graphics terminal in order to overlay one survey on top of the next. This technique made it readily apparent that an impression was created approximately 1,600 feet wide, 2,800 feet long, and 11 feet high with side slopes of 1 on 130. This was seen between the surveys of June 1982 and February 1983. Between February 1983 and February 1985, there has been a change in elevation on the crest of the impression from about -23 feet to -25 feet.

Vertical movements of the survey vessel caused by ocean waves and long period swells introduce error to the depth soundings. The comparison of a sounding at a particular location at one point in time with another sounding taken at a corresponding location at some other point in time may, or may not, reflect this vertical error. On the six surveys performed over the Dam Neck Test Area, this error could have been as much as nine tenths of a foot ($\pm$ 0.9'). However, because a survey is completed in a relatively short period of time, this error has a consistent harmonic fluctuation through that survey. When computing material volume estimates, or comparing contours, this harmonic fluctuation actually minimizes its own errors.

Material volume computations were completed for each survey over the entire survey area as well as on 1000-foot grid cells to measure any movement of the dredged material. This method detected the material placed by disposal operations, but, from February 1983 to February 1985 there was not a significant loss, or gain, of material. The difference in volume from one post-disposal survey to the next indicated a maximum vertical change between surveys of $\pm$ 0.05 feet or about one-half inch averaged over the disposal area.

Two-foot interval contours of the survey area were also processed through the Tektronix graphics terminal in order to overlay one survey on the next. After completion of disposal operations, each subsequent survey was consistent with all the others except at the 24 and 26-foot contours. The area within the 24-foot contour steadily decreased until February 1985 where the maximum elevation was -24.7 feet, therefore, there was no 24-foot contour. Between February 1983 and 1985, the area within the 26-foot contour decreased from about 7 acres to 3 acres. Volume computations based on these contours indicate a loss above the 26-foot contour of about 4,000 cubic yards of material. This would amount to 0.1 feet over the 1,000-foot grid cell used in the volume analysis and was therefore insignificant to be considered as gross movement when comparing volumes. The total area of the base of the disposal impression is about 100 acres. Therefore, the area affected by apparent movement is about 5 percent of the total.

During the span of this study, there were numerous wind events which created significant wave heights in excess of that needed in theory to induce movement of bottom sediment. For the average depth of water over the impression and sediment particle size of the dredged material, a wave with height of 2.1 feet and period of 7 seconds would move bottom sediments, (Ludick and Saumsiegle, 1976). Table 1. lists the signficant wind events and their derived wave heights and periods which occurred during the study. It was also concluded by Ludwick and Saumsiegle that wave induced sediment movement was oscillatory, and unless unbalanced, produced no net translation of particles at the Dam Neck Site. Additionally, they stated that sediment movement by currents at the site was of low intensity and infrequent in occurrence, with principal movement occurring only during storms.

V. CONCLUSION

It appears that the only loss of dredged material volume between February 1983 and February 1985 is a direct result of settlement or scour along the crest due to various storms which passed through the area. All apparent loss of dredged material was from the area above the 26-foot contour. A comparison of computations for each survey indicated the computed volume change was below the error limits of state-of-the-art bathymetric survey methods.

Table 1. Derived Significant Wave Height (Hs)

Date	Maximum Sustained Winds (mph)	Winds (Kts.)	Period (sec.)	Wave Height (Hs, ft.)
11 Feb 83	36	41	7.1	10.1
14 Feb 83	35	40	7.0	9.8
24 Mar 83	36	41	7.1	10.1
27 Feb 84	35	40	7.0	9.8
08 May 84	37	43	7.3	10.5
18 Jun 84	37	43	7.3	10.5
12 Sep 84*	38	44	7.5	11.5

* - Tropical Storm/Hurricane Diane

Sources:

1. Significant wave height (Hs) and period derived from figure 3-24, deepwater significant wave prediction, page 3-50, U.S. Army Corps of Engineers Shore Protection Manual, Fourth Edition, 1984, as limited by 6-hour duration.

2. Monthly Summaries (2/83 - 12/84) as compiled in the Local Climatological Data recorded at the National Weather Service Office, Norfolk International Airport, Norfolk, Virginia

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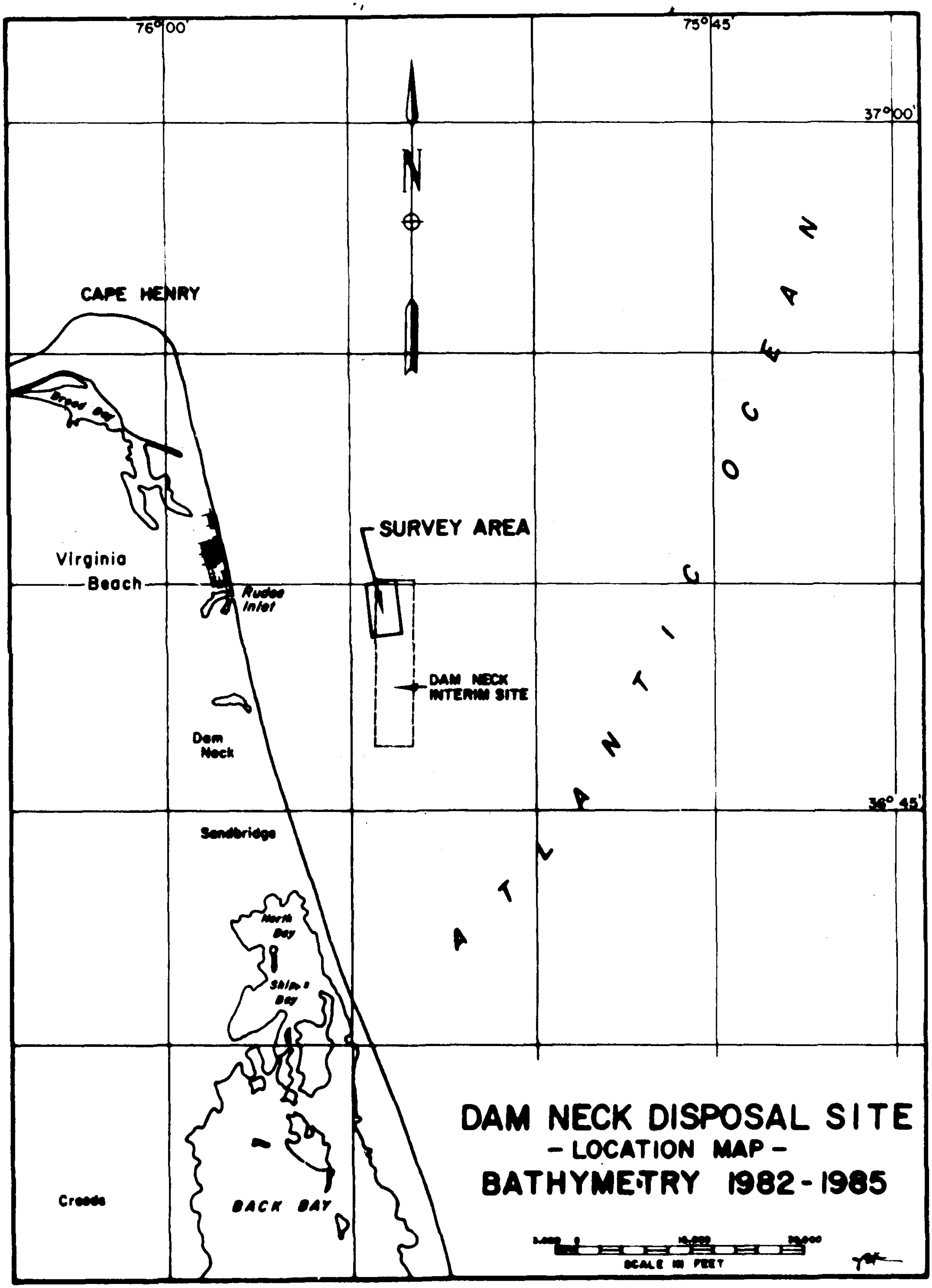
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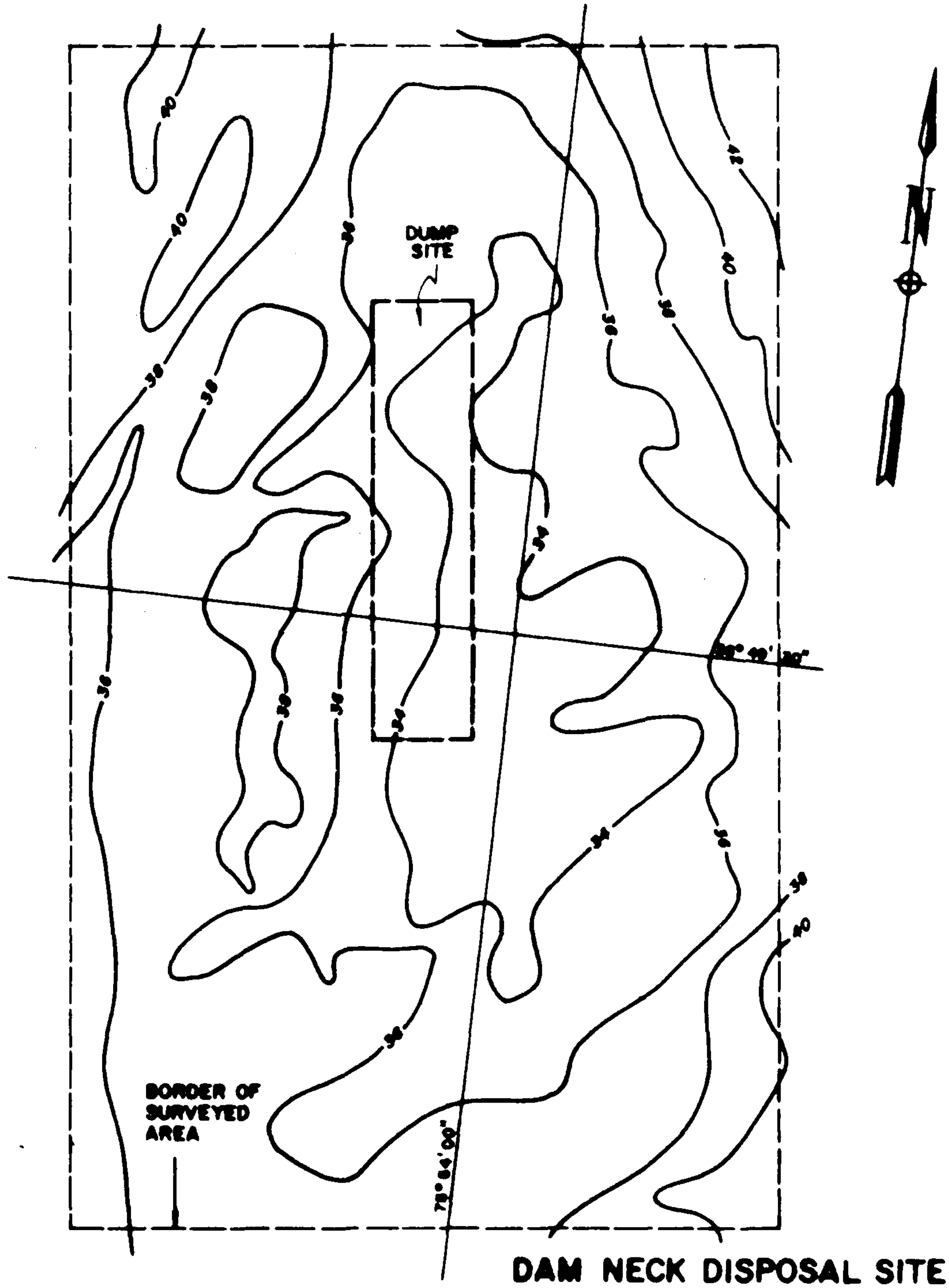
Broad Bay
SURVEY AREA
Virginia
Beach
Rudee
Inlet
DAM NECK
INTERIM SITE
Dam
Neck
Sandbridge
North
Bay
Back Bay
ATLANTIC OCEAN
Creeds
BACK BAY
DAM NECK DISPOSAL SITE
- LOCATION MAP -
BATHYMETRY 1982-1985
SCALE IN FEET

Fig 1

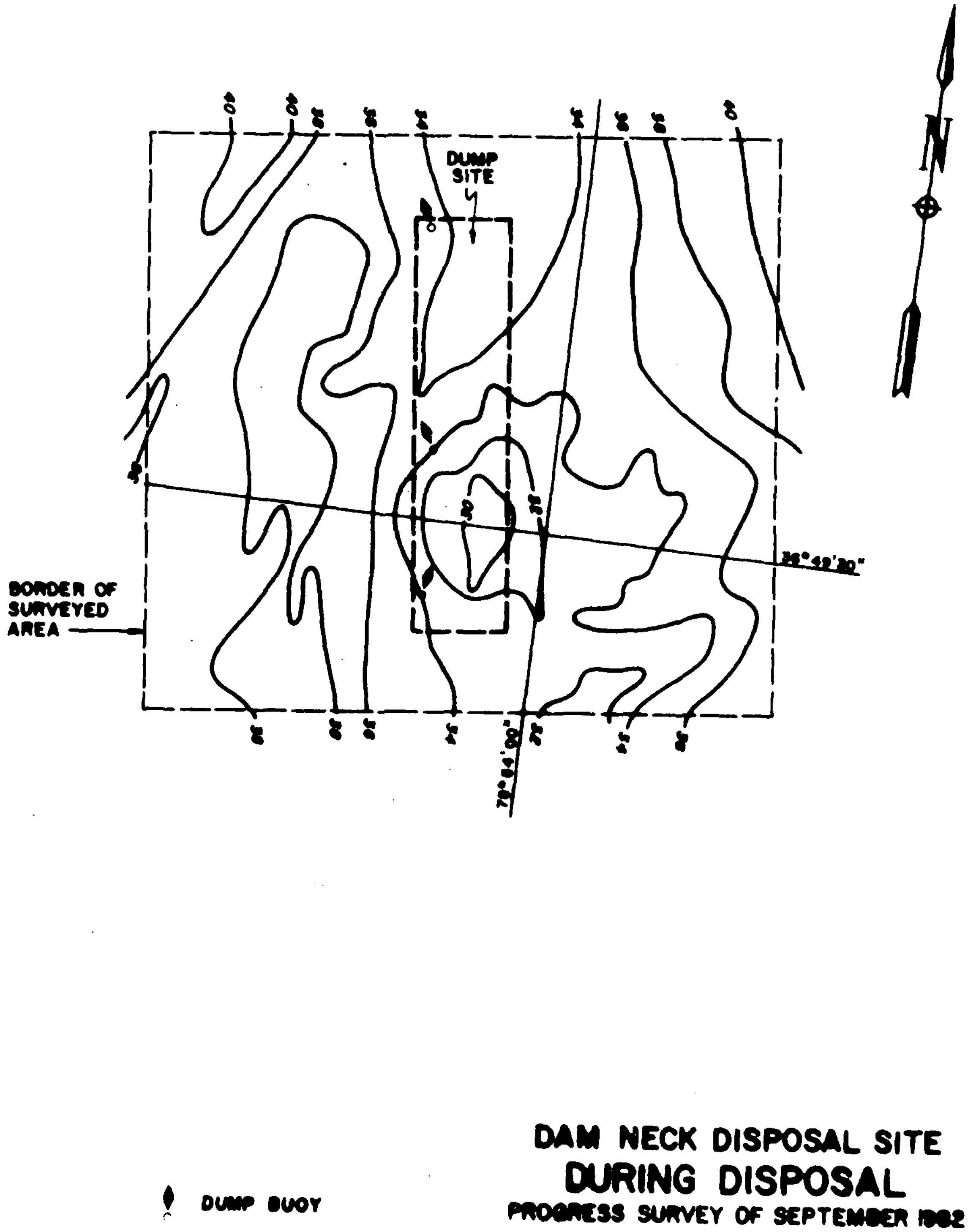


DAM NECK DISPOSAL SITE
BEFORE DISPOSAL
SURVEY OF JUNE - JULY 1982

500 0 1,000 2,000 FT

FROM CE FILE NO. H-31-10-92

Fig 2



DAM NECK DISPOSAL SITE

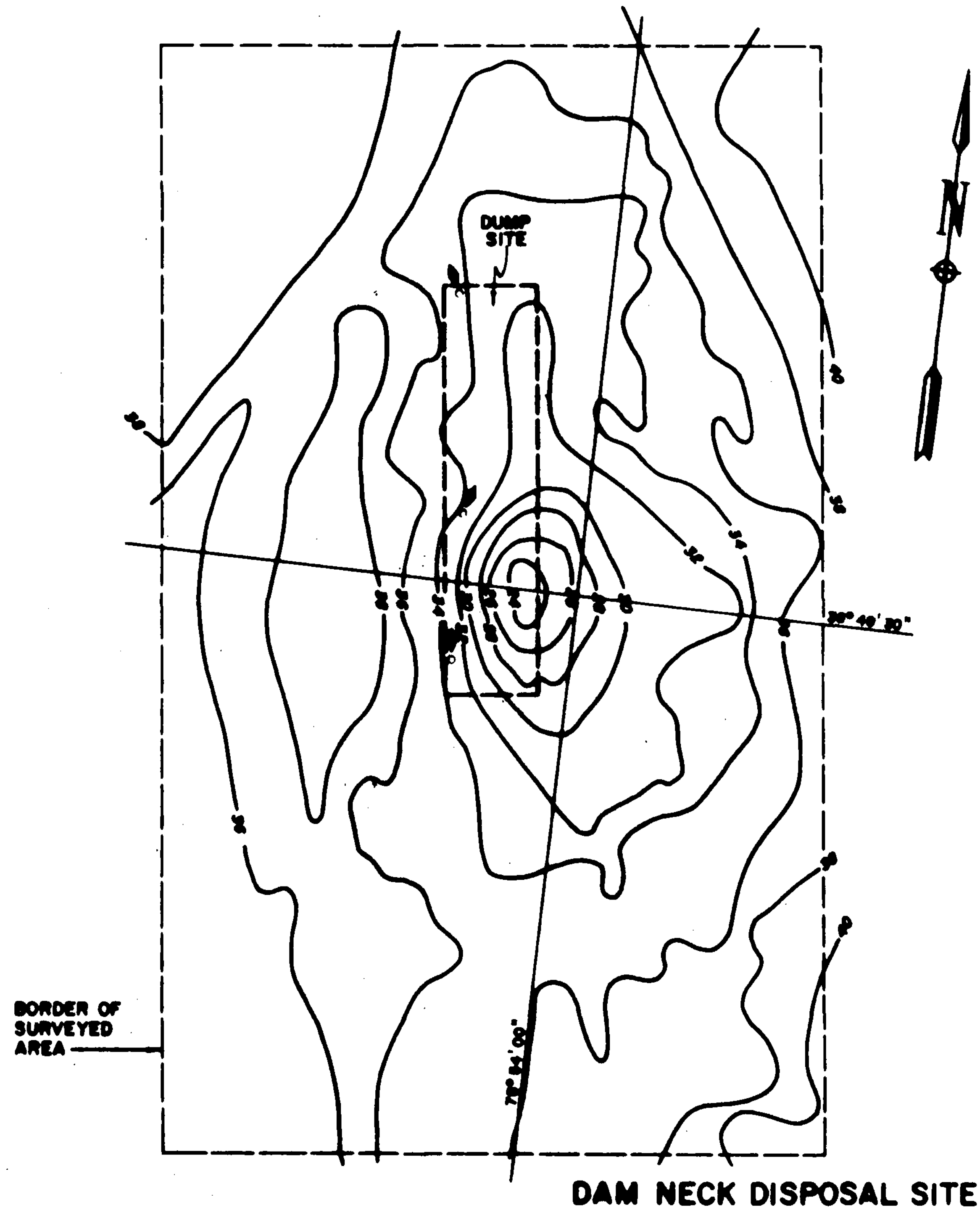
DURING DISPOSAL

PROGRESS SURVEY OF SEPTEMBER 1982

2,000 FT

FROM CE FILE NO. H-31-10-93

Fig 3



DAM NECK DISPOSAL SITE

AFTER DISPOSAL

SURVEY OF FEBRUARY 1983

DUMP BUOY

500 0 1,000 2,000 FT

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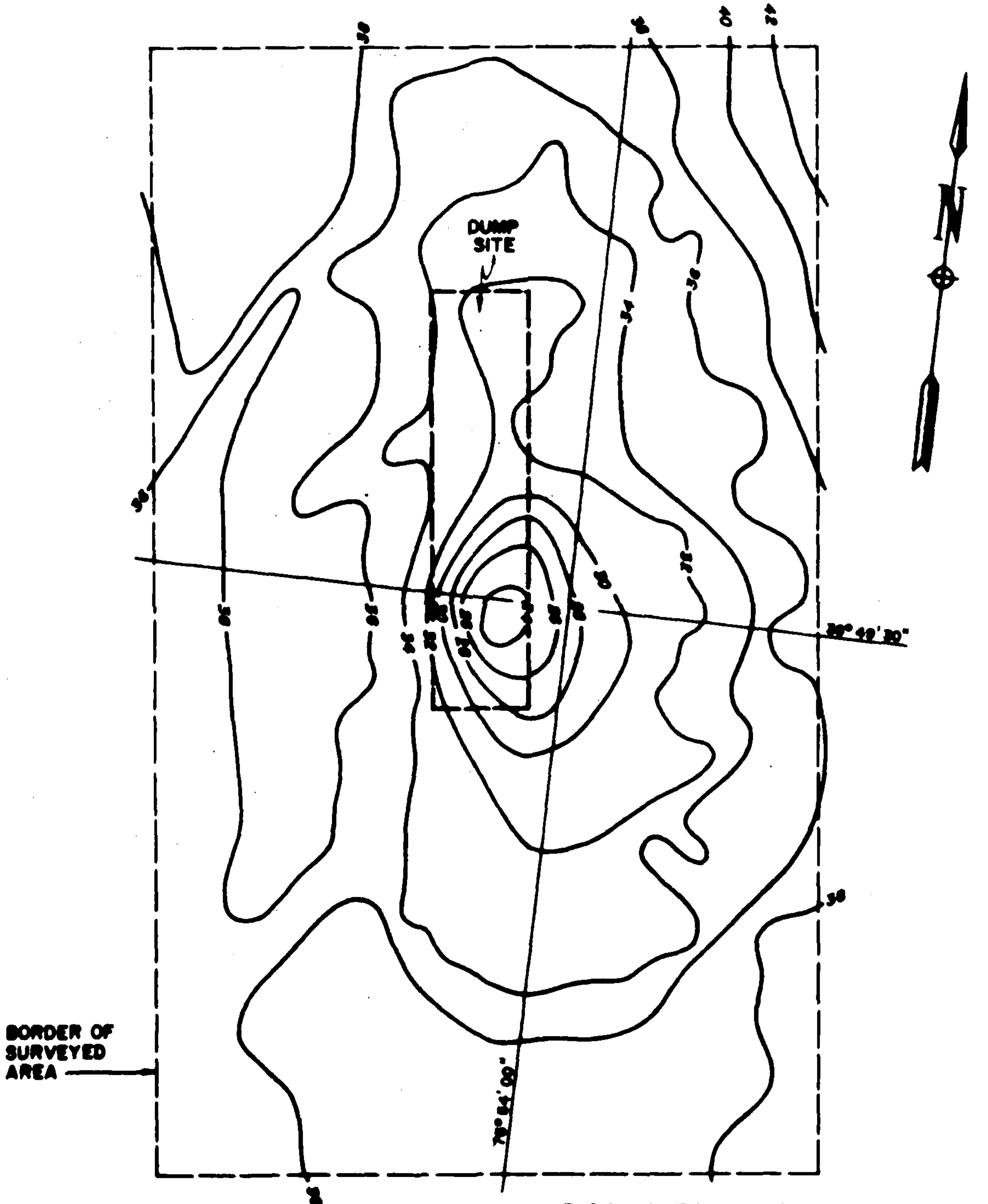
Fig 4



DAM NECK DISPOSAL SITE

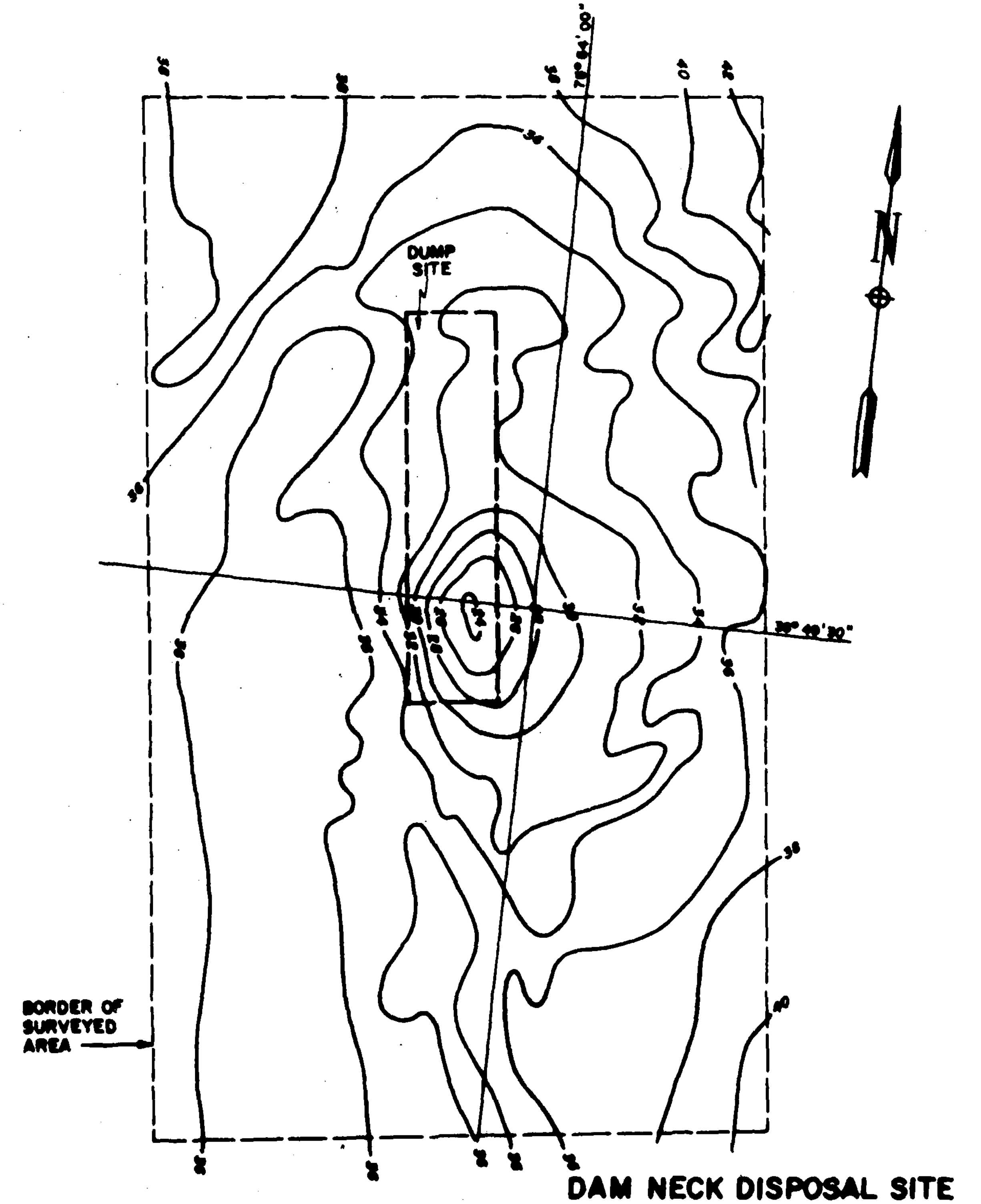
CONDITION SURVEY

SURVEY OF MAY - JUNE 1983

500 0 1,000 2,000 FT

FROM CE FILE NO. H-31-10-96

Fig 5



DAM NECK DISPOSAL SITE

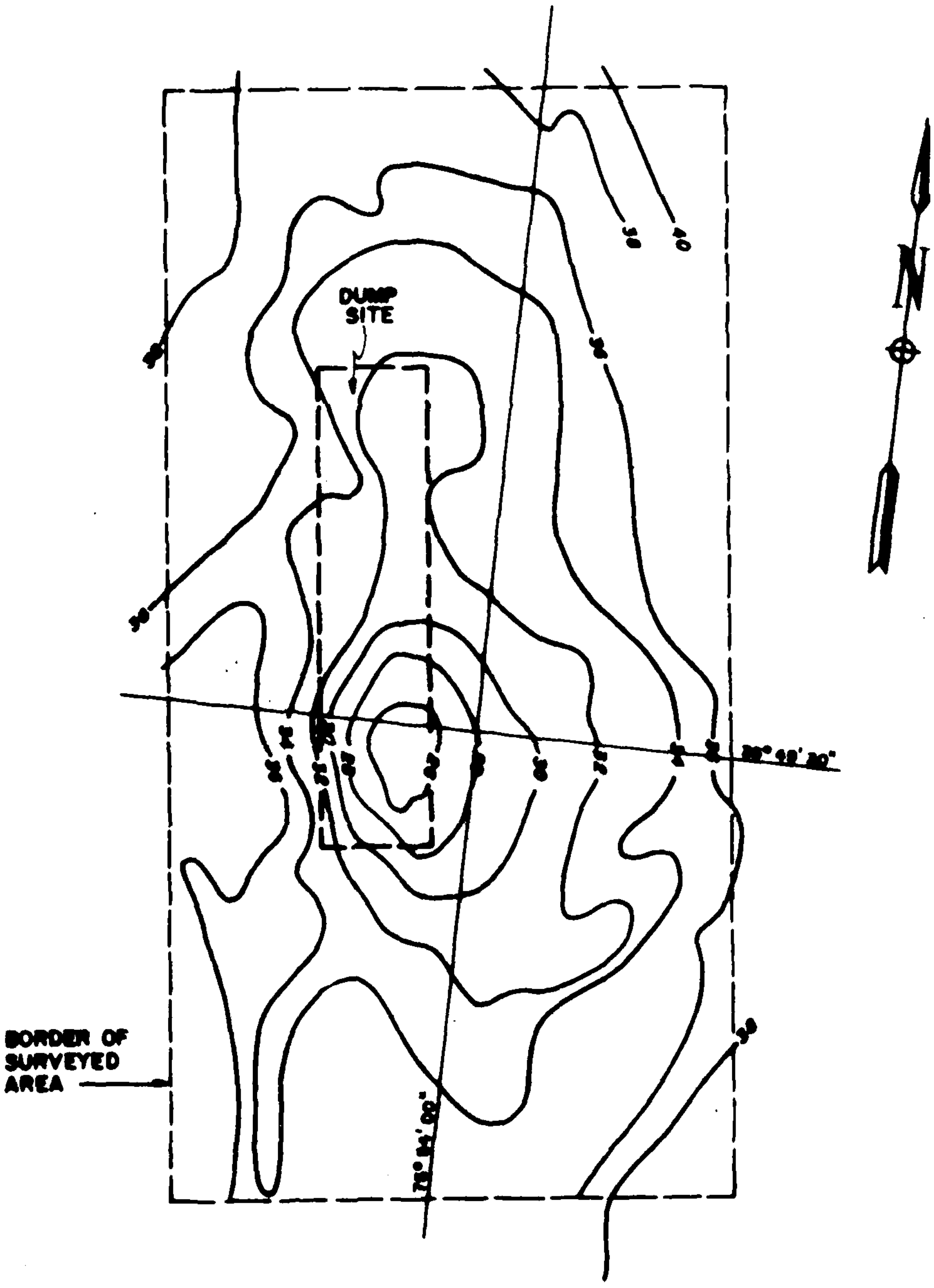
CONDITION SURVEY

SURVEY OF NOVEMBER 1983

500 0 1,000 2,000 FT

FROM CE FILE NO. H-31-10-97

Fig 6



DAM NECK DISPOSAL SITE

CONDITION SURVEY

SURVEY OF FEBRUARY 1985

500 0 1,000 2,000 FT

FROM CE FILE NO. H-31-10-98

Fig 7

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